This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

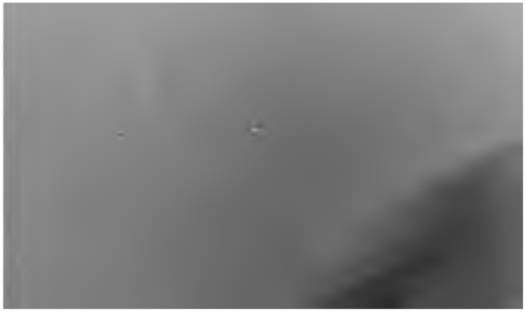
+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

15521. d. 2

600045811P



UNIVERSITY OF EDINBURGH
ZOOLOGICAL LABORATORY.

THE DISSECTION

OF

THE FROG.

BY

J. COSSAR EWART, M.D.,
REGIUS PROFESSOR OF NATURAL HISTORY IN THE UNIVERSITY OF EDINBURGH.

EDINBURGH:
JAMES THIN, PUBLISHER TO THE UNIVERSITY.
1884.

c
16521. d. 2

BODLEIAN LIBRARY
1 JAN 85
OXFORD.

THE FROG; *Rana temporaria and R. esculenta.*

Examine a living frog in an aquarium, noting,—the walking, leaping, and swimming movements; the colour of the skin under different circumstances; the attitude when at rest; the depressed rounded body; the absence of a neck and tail, the short fore limbs and the inverted manus; the sacral "hump" at junction of vertebral column with urostyle; the long femur and crus, and the greatly elongated webbed pes. Study movements of external nostrils and floor of mouth in respiration; the elevation and depression of lower eyelid, and, if possible, the method of feeding; and in the male edible frog the expansion of the vocal sacs during croaking.

A. External Characters.

1. Make an outline sketch of the frog from the side, and indicate—
    - (*a*) The mottled colour of the skin.
    - (*b*) The eye, with the semi-transparent lower eyelid half raised.
    - (*c*) The interocular gland and the dark patch behind the eye containing the tympanic membrane.
    - (*d*) The extent of the gape, the position of the external nostrils, and the opening of the cloaca.
2. Sketch—
    - (*a*) The manus (4 times nat. size), showing callosities on palmar aspect, and if a male the swollen cushion at base of index.
    - (*b*) The pes (2 nat. size), showing the long tarsal region and the webbed digits.
3. Number the digits in both limbs from within outwards, noting the short hallux (I) with a spur at its base, and the long IV. digit of the pes.
4. Examine (low power) and sketch—
    - (*a*) A portion of the web showing the branched pigment cells and the blood-vessels.
    - (*b*) A portion of the epidermis, showing openings of unicellular and spherical cutaneous glands.

B. Buccal Cavity.

1. Open mouth, and note—
   - (*a*) The premaxillary, maxillary, and vomerine teeth, the projection of the eyeballs, the internal nares and Eustachian tubes.
   - (*b*) The absence of mandibular teeth, the position, form, and mobility of the tongue, the lingual veins; the glottis and wide œsophagus, and if a male edible frog the openings into the vocal sacs.
2. Sketch—
   - (*a*) The roof of the mouth, showing a bristle passing from one of the external nostrils into the mouth, and another through the drum of the ear along the Eustachian tube.
   - (*b*) The floor of the mouth, showing the tongue connected to the hyoid cartilage, the glottis, and (if present) the openings of the vocal sacs.

C. Circulatory, Respiratory, and Alimentary Systems.

1. Fix the frog on its back by means of pins through the fore and hind limbs, cover with water, and divide with scissors the skin along the middle line from the pelvis to the mandible, noting the large subcutaneous lymph spaces.
2. Pin back the skin, and make a sketch showing—
   - (*a*) The anterior abdominal vein running along the middle line under cover of the abdominal walls, to disappear behind the large xiphoid cartilage of the sternum.
   - (*b*) The right and left cutaneous and the brachial veins uniting under the pectoral muscles, the lingual and maxillary veins, and the hypoglossal nerve.
   - (*c*) The mylohyoid muscle, the sternal and abdominal portions of the pectoral muscle, the rectus abdominis, obliquus externus and obliquus internus muscles.
3. Make an incision along the wall of the abdomen a little to the left of the middle line, and observe under the right portion the anterior abdominal vein which originates from the pelvic veins, and after receiving the small cystic, parietal, and cardiac veins, divides to enter the right and left lobes of the liver.
4. (*a*) Carefully detach the abdominal vein from the muscles, or make an incision a little to the right of the vein, and reflect the abdominal walls; note the peritoneum lining the body cavity, and covering the viscera.
   (*b*) Remove the sternum and ventral portion of the pectoral girdle, so as to expose the heart and lungs, taking care not to injure the abdominal or cutaneous veins.
5. Indicate in an outline drawing of the frog—
   - (*a*) The heart lying within the pericardium.
   - (*b*) The lungs,—if collapsed, they should be inflated by introducing a blow-pipe through the glottis.
   - (*c*) The fibres of the rudimentary diaphragm attached to the œsophagus and the pericardium.
   - (*d*) The entire right and divided left lobes of the liver, and the gall bladder.
   - (*e*) The anterior abdominal vein entering the lobes of the liver, and its cystic and cardiac branches.
   - (*f*) The exposed portions of stomach, duodenum, small and large intestine, the mesentery, and mesenteric veins.
   - (*g*) The bilobed bladder which, if necessary, may be inflated from the cloaca.
   - (*h*) If a female, the ovaries, corpora adiposa, and the long convoluted *oviducts.*

6. Examine the peritoneum, tracing it from each side to the under surface of the vertebral column where it is reflected as a double layer to form the mesentery and provide sacs or folds for the abdominal viscera.
7. If a female, examine and remove the ovaries and oviducts. For directions see page 12.
8. Note, without injuring the peritoneum, the position and relations of the following structures to be afterwards examined—
   (*a*) The liver and gall bladder; (*b*) the stomach and duodenum, with (*c*) the pancreas lying between them; (*d*) the small and large intestine, and (*e*) the spleen near their junction; (*f*) the testes yellow oval bodies in front of (*g*), the flattened dark-red kidneys; (*h*) the bilobed bladder projecting from the front wall of the cloaca.
9. Examine and make a diagram (4 nat. size) of the following veins—
   (*a*) System of the superior vena cava, consisting of—
      (1) The external jugular formed by the lingual and mandibular.
      (2) The innominate formed by the internal jugular and subscapular.
      (3) The subclavian formed by the brachial and the musculo-cutaneous.

   Cut open the pericardium, tilt forward the apex of the heart, and observe the two superior venæ cavæ entering the sinus venosus.

   (*b*) System of the inferior vena cava—

   The femoral and sciatic veins carry the blood from the hind limb. Each femoral divides to form a pelvic vein, the anterior branches of the two pelvic veins by uniting in the middle line give rise to the anterior abdominal vein, while the posterior branches by uniting with the sciatics form the renal portal veins.

   The system of the inferior vena cava includes—
      (1) The renal portal vein which formed by the union of the posterior division of the pelvic vein with the sciatic, receives the dorso-lumbar vein (from the posterior walls of the abdomen and from the oviducts in the female) as it enters the outer margin of the kidney.
      (2) The anterior abdominal vein formed by the union of the anterior ends of the two pelvic veins: after receiving cystic, parietal, and cardiac branches, it enters the liver.
      (3) The hepatic portal vein formed by the union of the gastric, splenic, and mesenteric veins (the splenic usually uniting with one of the mesenteric veins). It unites with the branches of the anterior abdominal vein and enters the liver.
      (4) The renal veins (4 or 5) which unite to form the inferior vena cava. The vena cava receives.
         (*i*) The ovarian or spermatic veins, and
         (*ii*) The right and left hepatic veins, and then opens into the sinus venosus.

   (*c*) System of the pulmonary veins. Trace the pulmonary veins from the lungs, and observe that they unite to form a single trunk which opens into the left auricle.

10. The heart and arteries.

a. The Arteries.

Distend the œsophagus with a cylindrical piece of wood or a roll of paper, and after carefully cleaning the aortic arches, study and make a diagram (4 nat. size) of the heart, truncus arteriosus, and the following arteries—

(*a*) The carotid arch, giving off

(1) The lingual artery.

(2) The carotid artery, which arises from the carotid gland, and divides into an external carotid branch and an internal carotid branch—the latter entering the cranium supplies the brain.

(*b*) The systemic arch (4th arch of fish, 2nd of tadpole) which bending round the œsophagus unites with its fellow of the opposite side to form the dorsal aorta. Each arch gives off the following branches before uniting—

(1) The laryngeal artery.
(2) The œsophageal arteries.
(3) The occipito-vertebral artery.
(4) The subclavian, for the shoulder and fore limb.

The dorsal aorta gives off—

(1) The cœliaco-mesenteric which divides into (i) the cœliac for the stomach and liver, and (ii) the mesenteric for the intestines and spleen. The cœliaco-mesenteric sometimes arises from the left systemic arch.

(2) The urino-genital arteries, for the kidneys, genital organs, and fatty bodies.

(3) Lumbar branches for the body walls, and a small median branch (hæmorrhoidal) for the large intestine.

(4) The iliac arteries (the terminal bifurcation of the dorsal aorta) which supply the bladder (hypogastric) and the anterior walls of abdomen (epigastric); each then extends along the thigh as a femoral artery, and each femoral divides into a tibial and peroneal branch.

(*c*) The pulmo-cutaneous arch, dividing into

(1) The pulmonary artery for the lung, and

(2) The cutaneous which supplies the skin of the back and sends small branches to the side of the head.

The thyroid gland is represented by small bright oval bodies in connection with the lingual arteries, and between the systemic and pulmo-cutaneous arches, the thymus by two small round bodies, one behind each suspensorium. The spleen lies near the large intestine and the adrenal glands are embedded in front of the kidneys.

The mandibular branches of the 5th and 7th, and all the branches of the 9th and 10th cranial nerves, and of the 1st spinal nerve should now be examined. For description see pages 26, 28, and 32.

b. The Heart and Blood.

(*a*) Examine a drop of blood (high power). Observe—and draw
   (1) The oval nucleated yellowish-red corpuscles which, when seen on edge, have a flattened appearance.
   (2) The granular amœboid colourless corpuscles which are few in number and often provided with two or more nuclei.

(*b*) Cut out the heart leaving portions of the large vessels attached, and examine it in a watch-glass filled with spirit. Observe the divisions; sinus venosus, atrium, ventricle, and truncus arteriosus.
   (1) Open the atrium and observe the septum dividing it into two chambers; notice the opening of the sinus venosus to the right of the septum, into the large right auricle and the opening of the united pulmonary veins to the left of the septum into the small left auricle.
   (2) Open the truncus arteriosus longitudinally, and observe the longitudinal valve which separates the left passage leading to the opening into the pulmo-cutaneous arches, from the right leading to the carotid and systemic arches. Observe also the semilunar valves which separate the synangium from the pylangium and the pylangium from the ventricle.
   (3) Cut across the ventricle and notice the small cavity and the thick spongy walls.

(*c*) Make a sketch (6 nat. size) showing the cavities of the heart and truncus arteriosus, and the various valves.

11. The Larynx and Lungs.

Expose the hyoid apparatus by removing the muscles attached to its under surface, introduce a probe through the glottis into the right lung, remove the ventral wall of the laryngeal chamber, and slit up the right lung along the probe with a pair of scissors.

Examine and sketch (2 nat. size)—the lower jaw to be included in the sketch—
   (*a*) The hyoid indicating the body and the anterior and posterior cornua.
   (*b*) The larynx showing the arytenoid and laryngo-tracheal cartilages, and the vocal cords stretching across the small laryngeal chamber.
   (*c*) The lungs indicating the sacculated cavity of the right lung in direct communication with the air chamber.

12. The Alimentary Canal.
   (*a*) Observe the wide œsophagus; the tubular stomach distinctly separated from the duodenum by the pyloric constriction, the gall bladder lying between the divided left lobe and the smaller entire right lobe of the liver, the bile duct entering the duodenum, the pancreas sending numerous ducts into the bile duct, the spleen attached to the mesentery, the small and large intestine, and the cloaca.
   (*b*) Cut across the œsophagus, immediately behind the posterior cornua of the hyoid and the large intestine at its junction with the cloaca, and then remove the whole length of the alimentary canal, taking with it the lungs, liver, pancreas, and spleen, but leaving the dorsal aorta and kidneys. Uncoil the intestine and make a drawing showing all the structures removed.
   (*c*) Slit open the alimentary canal, and note the longitudinal folds of the stomach, the pyloric valve, the transverse folds of the duodenum, and the opening of the common bile duct.

D. Reproductive Organs and Kidneys.

1. The female frog.
    - *a.* The reproductive organs—
      Observe—
        - (*a*). The ovaries suspended by peritoneum in front of the kidneys, the ova projecting from the surface of the ovaries and the fatty bodies from their upper ends.
        - (*b*). The long convoluted oviducts opening in front by small apertures into the body cavity, and after dilating opening behind into the cloaca.

      Make a diagram showing the ovaries, fatty bodies, and oviducts.

      Make an incision into one of the ovaries, and note that the ova project freely into the central cavity, and that in addition to the mature dark ova (abundant during the breeding season), there are numerous, almost colourless, developing ova. Examine a portion of the ovary containing young ova, first with low and then with high power, and draw an ovum showing the vitelline membrane, vitellus, germinal vesicle, and germinal spots.
    - *b.* The kidneys—
      Observe that they lie in a lymph space behind the peritoneum, and that a simple duct passes from each to open separately into the dorsal wall of the cloaca.

      Make a diagram showing the kidneys, adrenal glands, ureters, and cloaca.
2. The male frog.
    Observe—
    - (*a*) The kidneys lying behind the peritoneum.
    - (*b*) The testes suspended by peritoneum in front of the kidneys.
    - (*c*) The delicate vasa efferentia which carry the spermatozoa from the testes into the tubules of the kidney.
    - (*d*) The duct (Wolffian) which extends from the outer margin of each kidney to the cloaca, and acts both as vas deferens and ureter.
    - (*e*) The vesicula seminalis developed in connection with the outer margin of each duct—in R. esculenta the vesicula seminalis is represented by a simple dilation of the common duct.

    Make a diagram showing the testes, vasa efferentia, kidneys, common ducts, vesiculæ seminalis, and cloaca.

    Cut open the cloaca and look for the openings of the oviducts and ureters, and also for the rectal and vesicle openings.

    Examine (high power) a small portion of testis; note and draw the spermatozoa.

    Examine again the dorsal aorta, noting especially the branches to the kidneys and genital organs, and its bifurcation into the two iliacs, and then proceed to study the sympathetic nervous system and the 2d to 10th spinal nerves and their principal branches. For spinal and sympathetic nerves, see pages 30 and 32.

E. The Skeleton.

Before beginning the examination of the skeleton the frog may be immersed for two or three minutes in boiling water.

1. The skull.
    - *a.* Remove the skin and subcutaneous tissues from the roof of the skull, and observe the parieto-frontals and nasals, the premaxillæ, maxillæ, and squamosals, the quadrato-jugals, and the exposed portions of the exoccipitals, prootics, and sphenethmoid.
    - *b.* Remove the mucous membrane from the roof of the mouth, and observe the parasphenoid and vomers, the pterygoids, and palatines, and the under surface of the maxillæ, premaxillæ, and quadrato-jugals, and the exposed portions of the exoccipitals, prootics, and sphenethmoid.
    - *c.* Examine the mandibular arch—
        - (*a*) The upper portion (quadrate cartilage) known as the suspensorium ; note that it supports the squamosal, and serves by its lower end for the attachment of the mandible, while it is united by its upper end to the auditory capsule.
        - (*b*) The lower portion or mandible, each half of which consists partly of cartilage (Meckels), and partly of cartilage bones—the long angulo-splenial underneath, and the small mento-meckelian at the symphysis, and the dentary on the upper margin.
    - *d.* Examine the hyoid arch, noting—
        - (*a*) The columella in connection externally through a piece of cartilage (suprastapedial) with the membrana tympani, and fixed by its inner end to the stapes.
        - (*b*) The anterior process of the hyoid attached to the auditory capsule below the fenestra ovalis.
        - (*c*) The body consisting of the fused ventral portions of the hyoid and the four branchial arches of the tadpole.
        - (*d*) The ossified posterior processes (remains of fourth branchial arch) which project obliquely backwards one at each side of the larynx.
    - *e.* Draw (2 nat. size)—*
        - (*a*) The hyoid arch, showing the anterior and posterior cornua, and the short processes from the angles of the body.
        - (*b*) The upper surface of the skull, showing—
            - (1) The membrane bones,—parieto-frontals, nasals, premaxillæ, maxillæ, and squamosals.
            - (2) The cartilage bones,—exoccipitals, sphenethmoid, prootics, and quadrato-jugals.
        - (*c*) The under surface of the skull, showing—
            - (1) The membrane bones,—parasphenoid, vomers, premaxillæ, and maxillæ.
            - (2) The cartilage bones,—exoccipitals, sphenethmoid, pterygoid, palatine, prootic, and quadrato-jugals.
        - (*d*) The mandible, showing Meckels, cartilage, and the angulo-splenial, mento-meckelian, and dentary bones.

---

* The cartilage should be coloured blue, and the cartilage bones dotted by way of distinguishing them from the membrane bones.

(*f*) Remove carefully, under water, the parieto-frontals, the right nasal, the right premaxillæ, maxillæ, and squamosal. Examine and make a sketch (2 nat. size), showing the exposed portion of the chondrocranium, the large anterior fontanelle, and the two small posterior fontanelles, the exoccipitals, sphenethmoid, prootics, and quadratojugals; and, in addition, on the left side, the nasal, premaxillæ, maxillæ, and squamosal.

(*g*) Remove the skull from the vertebral column, and make a sketch (2 nat. size) of the posterior aspect, showing the condyles (formed by the exoccipitals) at each side of the foramen magnum, the prootics, the columellæ, and the upper ends of the anterior cornua of the hyoid, the tympanic ring, and the suspensorium enclosed between the squamosals and pterygoids.

2. The vertebral column.

a. Expose and make a drawing (2 nat. size) of the dorsal surface of the vertebral column, showing the nine vertebræ and the long urostyle, and indicate also the pelvic arch in connection with the large transverse processes of the ninth vertebra (sacrum).

b. Observe the intervertebral foramina and the intervertebral discs, and then examine the individual vertebræ, noting that the 2d to the 7th resemble each other, while the 1st, 8th, and 9th are peculiar.

c. Make drawings (4 nat. size) of the 1st, 3d, 8th, and 9th vertebræ.

(*a*) The 1st or atlas vertebra. Indicate the forward projection of the centrum, the narrow arch and rudimentary spine, the concave facets for the occipital condyles, and the flattened articular processes for the second vertebra, and note the absence of transverse processes.

(*b*) The 3d vertebra. Indicate the procœlous centrum, the neural arch and its spine, the anterior and posterior articular processes (zygapophyses), and the large transverse processes.

(*c*) The 8th vertebra. Indicate in a section that the centrum is amphicœlous.

(*d*) The 9th vertebra (sacrum). Indicate the single convex anterior facet for the 8th vertebra, the two convex posterior facets for the urostyle, and the long expanded transverse processes which support the ilia.

d. Make a sketch of the urostyle, showing the two facets in front, the cartilage projecting from the hollow posterior end, the dorsal ridge, and the small aperture through which the 10th spinal nerve escapes from the canal in the front of the ridge.

3. The pectoral girdle and sternum. (To be examined in the second frog after the muscles have been dissected.)
    - *a*. The sternum note from before backwards.
        - (*a*) The episternum, a small circular plate of cartilage.
        - (*b*) The narrow bony omosternum.
        - (*c*) The epicoracoids, consisting of a piece of cartilage at each side of the middle line between the coracoids.
        - (*d*) The sternum proper, consisting externally of bone and internally of cartilage.
        - (*e*) The large bifid cartilaginous xiphisternum.
    - *b*. The pectoral girdle. Observe—
        - (*a*) The præcoracoid, a narrow bar of cartilage extending from the sternum to the anterior margin of the scapula.
        - (*b*) The post-coracoid, a flattened bone extending from the sternum to the posterior margin of the scapula and entering into the formation of the glenoid cavity.
        - (*c*) The clavicle (a membrane bone) ensheathing the anterior margin of the præcoracoid.
        - (*d*) The scapula, a short expanded bony plate which forms the upper portion of the glenoid cavity.
        - (*e*) The suprascapula, a large thin plate of cartilage in which a limited amount of osseous and calcareous matter is usually deposited.

    Make a drawing (2 nat. size) showing the sternum and pectoral girdle, colouring the cartilage blue and the clavicle red, in order to distinguish it from the cartilage bones.

4. The fore-limb.

Remove the muscles and examine the bones, and make a sketch (2 nat. size) showing—
- (*a*) The humerus with a rounded head, deltoid and condylar ridges, and a spheroidal articular surface for the radio-ulna.
- (*b*) The radio-ulna concave and simple above, with an olecranon process, but divided below and presenting three facets for the carpals.
- (*c*) The six carpals—radiale, ulnare, centrale, and three distalia.
- (*d*) The metacarpals and phalanges of the digits—the 1st digit (pollex) having no phalanges; the II. and III. digits, two phalanges each; and the IV. and V., three phalanges each.

5. The pelvic girdle.

Note that all three portions of the girdle enter into the acetabulum, the ilium forming the largest ($\frac{1}{2}$), and the pubes the smallest segment ($\frac{1}{6}$).

Examine—(*a*) The ilia, noting the crests, and that the two bones held apart in front by the long processes of the sacrum unite behind to form an iliac symphysis; (*b*) the ischia fused together and forming a median crest; (*c*) the pubes, represented by a small triangular piece of cartilage. Make a drawing (2 nat. size) showing the pelvic girdle from the side.

6. The hind-limb.

Examine the hind-limb, noting—

- (*a*) The long slender curved femur with a spherical head and a laterally expanded lower end.
- (*b*) The tibio-fibula, longer than the femur but less curved, and with both ends expanded and a distinct groove indicating the line of union of the two bones.
- (*c*) In the tarsal region—
  - (1) The greatly elongated tibiale (artragalus) and fibulare (calcaneum), separate in the middle but connected above and below by epiphyses.
  - (2) The small distal tarsals and the nodules which support the spur.
- (*d*) In the foot—
  - The five complete digits; the I. (hallux) and II. with two phalanges each, the III. and V. with three each, and the long IV. digit with four phalanges.

Make a sketch of the hind-limb (nat. size) and of transverse sections of the femur and tibio-fibula (2 nat. size).

F. The Nervous and Muscular Systems and Sense Organs (*second frog*).

1. Reflect the skin along the back and notice the large lymph spaces, the cutaneous branches of the dorsal nerves crossing them, and the position of the lymph hearts—one at each side of the urostyle, and one within the margin of each supra-scapula.
2. Examine the following muscles—
    - (*a*) The depressor mandibuli, which extends from the skull over the scapula to the angle of the jaw.
    - (*b*) The trapezius, extending from the exoccipital to the dorsal border of the scapula.
    - (*c*) The latissimus dorsi, extending from the dorsal fascia behind the scapula to be inserted into the deltoid ridge of the humerus.
    - (*d*) The temporal, passing from the auditory capsule to the coronoid process of the mandible.
    - (*e*) The pterygoid, which rises in front of the temporal and is inserted into the mandible behind the coronoid process.
    - (*f*) The masseter, from the quadrato-jugal to the outer surface of the mandible near its articulation.

    Observe that (*d*), (*e*), and (*f*) elevate the mandible.

    The pectoral girdle and sternum should now be examined (see page 8).
3. After noting, clear away the infraspinatus, levator anguli scapulæ, and retrahens scapulæ, and also the extensor dorsi communis and intertransversalis muscles, and the right supra-scapula. Cut across the membrane between the skull and the atlas, and then remove carefully the roof of the cranium so as to expose the brain by cutting from the foramen magnum first through the side walls, and then across in front of the parieto-frontals. Expose the spinal cord and filum terminale by removing the neural arches and the upper segment of the canal of the urostyle.
4. Remove the pigmented pia mater, note and draw (3 nat. size) the olfactory and cerebral lobes, the optic thalami (indicating the position of the pineal gland, probably removed with the roof of the skull), the optic lobes, cerebellum and medulla oblongata, and the spinal cord (showing the brachial and lumbar enlargements), the dorsal fissure, and the filum terminale.
5. Examine the cavities of the brain.
    - (*a*) The fourth ventricle, a triangular space behind the cerebellum roofed over by a vascular membrane.
    - (*b*) The iter, a narrow passage leading from the fourth to the third ventricle.
    - (*c*) The cavities of the optic lobes which communicate with the iter.
    - (*d*) The third ventricle situated between the optic thalami and covered by the choroid plexus. Remove the plexus, noting the hollow peduncle of the pineal gland projecting from the roof of the ventricle, the band of fibres known as the posterior commissure, also the infundibulum projecting downwards towards the pituitary body.
    - (*e*) The lateral ventricles. Each communicates by a small aperture (the foramen of Monro) with the third ventricle, and extends a short distance into the olfactory lobe.

    In an outline sketch of the brain (3 nat. size), indicate the cavities mentioned.
6. Examine the olfactory bulbs, and expose the olfactory sacs in order to see the smelling membrane in which the olfactory nerves terminate.

    Make a sketch (4 nat. size) showing the two chambers (one opened) and the olfactory nerves.

7. Cut across the medulla, and then raise the cerebral lobes, and after noting cut as near to the skull as possible the following nerves—
   (1) The optic nerves forming the chiasma as they extend towards the optic lobes.
   (2) The 3rd, 4th, and 6th nerves which pass to the muscles of the eye.
   (3) The 5th nerve running forwards to escape in front of the auditory capsule.
   (4) The 7th nerve passing out of the skull immediately behind the 5th.
   (5) The 8th, entering the auditory capsule.
   (6) The 9th and 10th, escaping by an aperture behind the auditory capsule.
8. Examine and sketch the under surface of the brain (3 nat. size), showing the cerebral lobes, the optic chiasma, the tuber cinereum and the pituitary body, the crura cerebri, the medulla oblongata, and the roots of the cranial nerves.
9. Examine the eye of the frog, and at the same time the eye of the sheep or ox.
   a. The frog—
      (*a*) Remove one of the eyes, and note the cornea, and behind it the elliptical pupil surrounded by the iris; also the sclerotic pierced by the optic nerve. Cut round the equator of the eye and observe (1) the choroid and retina; (2) the vitreous humour filling the cavity of the eyeball; and (3) in the anterior portion the lens, iris, and aqueous chamber.
   b. The ox or sheep.
      (*a*) Remove the muscles and other tissues so as to expose the sclerotic and optic nerve, and note the conjunctiva covering the cornea and extending over the anterior portion of the sclerotic, also the iris perforated by the pupil.
      (*b*) After puncturing the cornea and noting the aqueous humour which escapes from the anterior chamber, remove the cornea by cutting round the margin, and note the pupil, iris, lens, and posterior chamber, and the ciliary muscle which connects the outer margin of the iris to the cornea and sclerotic.
      (*c*) Separate the ciliary muscle from the cornea and sclerotic; remove the sclerotic from the anterior portion of the eyeball; observe the choroid and the vessels and nerves (ciliary) which reach it through the sclerotic. Raise a portion of the choroid and note the retina, and then after cutting through the choroid and retina by a circular incision midway between the outer margin of the iris and the equator of the eye, remove the lens and the structures in connection with it, and examine under water, noting (1) the anterior portion of the retina (ora serrata) lying within the choroid; (2) the circle of folds (ciliary processes) in front of the ora serrata projecting from the anterior portion of the choroid to fit into depressions on the outer margin (suspensory ligament) of the capsule of the lens; (3) the layer of dark pigment (uvea) on the posterior surface of the iris; (4) the capsule of the lens, and the lens after removal from its capsule.
   c. Examine next the posterior portion of the eye, noting (1) the vitreous humour enclosed by the delicate hyaloid membrane; (2) the retina lying between the vitreous humour and the choroid with blood vessels radiating in its substance from the point of entrance (blind spot) of the optic nerve; (3) the lustre of the greenish coloured tapetum lucidum.
   d. Indicate the structures seen in an ideal section (2 nat. size).

10. The III., IV., and VI. nerves and the muscles of the eye.
    - *a.* The oculo-motor (III.) sending branches to—
        - (*a*) The levator bulbi which extends from the side of the skull under the eyeball to the upper jaw, giving off a few fibres to act as a depressor of the lower eyelid.
        - (*b*) The superior, inferior, and internal recti which arise from the inner angle of the orbit and are inserted into the sclerotic.
        - (*c*) The inferior oblique, which extends from the palatine bone to the under surface of the sclerotic.
        - (*d*) The retractor bulbi which encloses the optic nerve.
    - *b.* The pathetic (IV.) supplying the superior oblique which extends from the palatine to the upper surface of the sclerotic.
    - *c.* The abducens (VI.) supplying the external rectus and the retractor of the bulb.
    - *d.* Make a sketch showing the optic nerve, the eyeball, and the muscles inserted into the sclerotic.
11. The Trigenimal (V.) which passes from the cranium in front of the auditory capsule and divides into—
    - *a.* The ophthalmic branch which extends forwards under the superior rectus muscle to communicate with the IV. nerve and supply the Harderian gland, nasal mucous membrane and the skin in the region of the nasal capsule.
    - *b.* The maxillary branch which runs forwards under the eyeball to reach the lower eyelid and the skin covering the upper jaw.
    - *c.* The mandibular branch which, at first continuous with the maxillary portion, bends round the inner surface of the upper jaw to reach and extend along the outer surface of the mandible. Look for branches to the temporal and pterygoid muscles and the skin covering the lower jaw.

    The ganglion (Gasserian) on the root of the V. nerve with which the VI. and VII. nerves and the sympathic are connected, lies in the foramen of the pro-otic bone.
12. The facial nerve (VII.) which leaves the skull immediately behind the trigeminal and divides into—
    - (*a*) The palatine branch which runs forwards under the orbit, and is distributed partly to the roof of the mouth and partly along with the mandibular branch of the V. to the front of the palate and the outer aspect of the mandible.
    - (*b*) The hyomandibular branch which runs outwards over the auditory capsule and columella to the angle of the mouth, where it divides, one portion extending towards the anterior cornu of the hyoid, the other running along the inner surface of the mandible to reach the symphysis.
13. The auditory nerve (VIII.) which enters the auditory capsule to terminate in the internal ear. For the anatomy of the auditory organ, see the "Dissection of the Skate."

The next three nerves (glossopharyngeal, vagus, and hypoglossal) are best examined in a dissection from below. See page 8. When the mylohyoid is removed, and the œsophagus distended, the hypoglossal will be seen appearing immediately in front of the brachial plexus, and then arching forwards in the substance of the genio-hyoid muscle to end in the muscles of the tongue. About two lines in front of the hypoglossal is the glossopharyngeal. It escapes from the skull behind the auditory capsule, and runs forward at first nearly parallel to the hypoglossal, but it soon crosses the hypoglossal as it passes to the base of the tongue. Running obliquely across the space between these two nerves at a deeper level is the vagus, while crossing the space it gives off the laryngeal nerve, and, after passing under the hypoglossal, it breaks up into branches for the heart, lungs, and stomach.

14. The glossopharyngeal nerve (IX.) leaves the skull along with the vagus immediately behind the auditory capsule, and divides into—
    - *a.* An anterior branch which bends round the auditory capsule to join the facial nerve in front of the columella.
    - *b.* A posterior branch, which, after passing under the petrohyoid muscle and the hypoglossal nerve, takes a sinuous course between the geniohyoid and the hyoglossus towards the base of the tongue, which it enters.
15. The pneumogastric or vagus (X.), which, immediately after passing through the skull, leaves the IX. nerve and expands to form a ganglion. After giving off branches to the dorsal muscles, it reaches the walls of the pharynx, and runs obliquely downwards and backwards to break up into the following branches—
    - *a.* The laryngeal branch, which, passing between the glossopharyngeal and hypoglossal nerves and over the pulmo-cutaneous artery, reaches and supplies the larynx.
    - *b.* The cardiac, which reaches the inter-auricular septum by passing dorsal to the pulmonary artery.
    - *c.* The pulmonary, which extends along the pulmonary artery to the lung.
    - *d.* The gastric, which extends downwards along the side of the œsophagus to reach the stomach.

    Indicate in ventral and lateral views of the head, the distribution of the V., VII., IX., and X. nerves.

16. The sympathetic nervous system. This system consists of two ganglionated cords, which anteriorly lie in contact with the vertebral column, while posteriorly they are in connection with the sides of the aorta. The anterior pair of ganglia communicate with the 1st spinal nerve and send branches forwards which, after communicating with the ganglia of the IX. and X. cranial nerves seem to end in the Gasserian ganglion. Each of the eight following ganglia are connected to their corresponding spinal nerves by a single commissure, while the tenth ganglion has several branches reaching it from the tenth (coccygeal) nerve.

Numerous small branches pass from the various ganglia to the adjacent viscera and blood vessels, and a special set of branches (cardiac) arise from the first ganglion to reach the auricles and the large vessels which pass to and from the heart, while other filaments, springing chiefly from the third, fourth, and fifth ganglia, unite to form a plexus (solar) on the dorsal aspect of the stomach.

Make a sketch showing a transverse section of the spinal cord, the roots of a pair of spinal nerves, and a pair of sympathetic ganglia connected to these nerves. Make a second sketch showing the 10 pairs of sympathetic ganglia, their connections with each other, and the cranial and spinal nerves and the cardiac and solar plexuses derived from them.

17. The spinal nerves. Observe that—
    - *a.* The hypoglossal (1st spinal nerve = XI. cranial of man), escapes between the first and second vertebræ to cross first the vagus and then the glossopharyngeal, it next passes beneath the mylohyoid muscle to reach the base of the tongue. Besides supplying the tongue muscles, it sends small branches to the muscles of the back and the floor of the mouth. Add this nerve to the sketch showing the V., VII., IX., and X.
    - *b.* The second and third spinal nerves unite immediately after escaping from the spinal canal to form the brachial nerve, which supplies the muscles of the shoulder, and then extends along the arm to divide into the radial and ulnar nerves for the forearm and hand.
    - *c.* The fourth, fifth, and sixth spinal nerves supply the skin and muscles of the trunk.
    - *d.* The seventh, eighth, and ninth spinal nerves run obliquely backwards (forming the larger part of the cauda equina), to escape behind their respective vertebræ, and unite to form the sciatic plexus. The seventh, before uniting with the eighth, sends branches (ileohypogastric and crural) to the walls of the abdomen, the skin and muscles of the thigh. The sciatic plexus condenses to form the sciatic nerve which extends along the thigh to divide above the knee into the tibial and peroneal nerves for the leg and foot.
    - *e.* The tenth nerve (coccygeal) escapes through a small aperture in the urostyle, and is distributed to the walls of the cloaca and bladder, and the other structures in the pelvic region.
18. Make a sketch (2 nat. size) showing the under surface of the brain and spinal cord, with the origin and principal branches of all the cranial and spinal nerves on the one side and the sympathetic system and sense organs on the other.

⁂ In preparing the above directions the Author is indebted to Mr J. T. Cunningham, B.A., for much valuable assistance.